Volume 9 Number 1/January 1959

The Psychological Record

a quarterly journal in theoretical and experimental psychology

PERIODICALS ESTATE
UNIV. OF DENVER LIBRARIES JAN 18

CONTENTS

A Further Analysis of the Effect of Satiation on the Sucking Response in Puppies: *W. T. James* 1

Perspectives in Psychology: Literature as Art and Knowledge: *Paul Swartz* 7

Acquisition of a Simple Running Response as a Function of Partial and Continuous Schedules of Reinforcement: *Donald F. Haggard* 11

Delayed Reinforcement and Runway Performance: *Edward L. Wike and Walter Kintsch* 19

The Effect of Intensity of Visual Stimulation upon Auditory Acuity: *W. L. Gulick and F. L. Smith* 29

Distal Cues and Latent Extinction: *M. Ray Denny and Stanley C. Ratner* 33

Books Received 36

Published at DENISON UNIVERSITY, Granville, Ohio

EDITOR
Irvin S. Wolf

MANAGING EDITOR
Paul T. Mountjoy

Denison University
Granville, Ohio

ASSOCIATE EDITORS

NEIL R. BARTLETT, *University of Arizona*
S. HOWARD BARTLEY, *Michigan State University*
J. R. KANTOR, *Indiana University*
W. N. KELLOGG, *Florida State University*
W. E. LAMBERT, *McGill University*
PARKER E. LICHTENSTEIN, *Denison University*
PAUL McREYNOLDS, *VA Hospital, Palo Alto, California*
N. H. PRONKO, *University of Wichita*
STANLEY C. RATNER, *Michigan State University*
WILLIAM STEPHENSON, *University of Missouri*
PAUL SWARTZ, *University of Wichita*
EDWARD L. WALKER, *University of Michigan*

THE PSYCHOLOGICAL RECORD is a non-profit publication. It is published quarterly, in January, April, July, and October, at Denison University, Granville, Ohio. Subscription price is $4.00 a year (APA members—$3.00; students—$1.50).

With the permission of the Principia Press, Inc., THE PSYCHOLOGICAL RECORD is a continuation of the journal formerly published under this title. Publication of THE PSYCHOLOGICAL RECORD was resumed in January, 1956.

As presently organized THE PSYCHOLOGICAL RECORD publishes both theoretical and experimental articles, commentary on current developments in psychology, and descriptions of research planned or in progress. The journal is designed to serve *a critical function in psychology*. It therefore favors the publication of papers that develop new approaches to the study of behavior and new methodologies, and which undertake critiques of existing approaches and methods.

Articles should be prepared according to the form suggested for APA publications (*APA Publication Manual*) and submitted in duplicate to the Editor. The author cost per page is $3.00. There is an additional author charge for cuts and special composition. Reprints are available at cost.

COPYRIGHT, 1959, BY IRVIN S. WOLF

The Psychological Record, 1959, 9, 1-6.

A FURTHER ANALYSIS OF THE EFFECT OF SATIATION ON THE SUCKING RESPONSE IN PUPPIES

W. T. JAMES

University of Georgia[1]

Following the emphasis of the psychoanalytic school on the significance of early experience for the development of behavior, great attention has been given to the sucking response. This school in particular has emphasized that the sucking "drive" must be satisfied, and that if it is not, the child will suck the fingers and show tension and nervousness. There is no doubt that the sucking reflex is important. It is certainly vital to food intake at birth, but whether it is a strong reflex important in food taking or an autonomous "drive" which will have a lasting effect if not satisfied, is another matter.

The proponents of the "sucking drive" theory have looked to studies on animals and children for support. A large part of the research on children has been summarized by Orlansky (1949). Beach and Jaynes (1954) have reviewed the various studies on the effect of sucking deprivation on the response and general behavior in mammals. A more recent review by Ross, Fisher & King (1957) gives a summary of the work to present.

In general, the experiments have been interested, first, in the mechanics of sucking behavior. These studies have described the nature of the sucking reflex, when it begins, the complex patterns of reflexes involved, and its relationship to various other behaviors as breathing and swallowing. These studies, and those of Halverson (1944; 1946), have given a good picture of the reflex systems involved, which in the child seems pretty well understood.

A second class of experiments has been directed to the significance of sucking behavior. Levy (1934) fed two puppies on fast feeding nipples and two others on slow feeding nipples with adequate satiation of sucking. Those which were fed on the free flowing nipples with inadequate sucking time tended to exhibit more extraneous sucking on each other and on various objects in the environment. Ross also did a study with puppies, some of which were bottle fed, others dropper fed, while some were left with the mother (1951a; 1951b). In general Ross seems to agree with Levy that there is a sucking drive which requires satisfaction. Both of these studies need to be repeated. The puppies on artifical feeding did not seem to grow normally, which may have been due to inadequate food. On the other hand, the criteria of extraneous

1 This research was supported by the Graduate School of the University of Georgia.

sucking and sucking pressure were not specific enough to be repeated. Although these studies are suggestive, they are not conclusive. There seems to be more conclusive evidence regarding this problem in children. The extensive study of Davis, Sears, Miller and Brodbeck (1948) on groups of babies fed by breast, cup or bottle, seems to show that those deprived of sucking grew about as normally as the others. If this study is substantiated by others, the idea that the sucking "drive" must be satisfied for normal health is doomed.

The third aspect of the problem is the significance of artificial feeding on personality. Some of these studies, as those of Hoefer and Hardy (1929), emphasize the importance of breast feeding, and indicate that children fed artificially do not grow as well and are not as healthy as breast fed children. Other studies have emphasized that artificially fed children do not sleep as well, have more enuresis, and nervousness as compared with breast fed children (Rogerson & Rogerson, 1939). On the other hand, many studies contradict these conclusions. Orlansky concludes that there is no evidence that breast feeding has any over-all advantage for the development of children in every case (1949). Many others agree with this conclusion.

Although every one agrees that the sucking reflex is of biological importance, more must be known about the reflex and its relation to food intake and satiation before its psychological significance can be determined. The question, particularly regarding satiation, has been neglected. It was in the interest of this problem that a series of experiments has been done at the University of Georgia on the relationship between food intake and sucking behavior. The first study investigated the relationship between food in the stomach and vigor of the reflex (James, 1957 a). In the experiments puppies were removed from the mother for an interval of time, then injected with Esbilac[2] and replaced with the mother to determine the sucking time and milk intake. It was found that the amount of milk in the stomach did not affect the sucking reflex. It seemed that sucking occurred whenever proper stimuli were present and was independent of milk in the stomach or milk intake. In many cases the puppies would suck for a long period of time with no milk intake at all. Elimination of sucking seemed to be due more to fatigue than a full stomach. In view of these surprising results a second experiment has been completed with slight variations.

PROBLEM

The object of the present study was to observe the effect of injected food on the sucking reflex. It differed from the first experiment by continuing the sucking studies longer before the weaning period, and included a number of tests in which injection was followed by opportunity for consummatory licking of milk, and then by sucking. The interest here was in determining whether eating after stomach injection would eliminate the sucking reflex.

2 Esbilac is a powdered milk which closely approximates that of the mother dog. It is manufactured by the Borden Company.

METHOD

Subjects

Three members of a litter, 2 males and 1 female, of 5 Beagle-Terrier hybrid puppies were used in all the tests.

Procedure

In the first part of the experiment the puppies were injected with milk and then placed with the mother to determine whether they would suck, and if so, how much milk they would consume. During this phase of the experiment a total of 28 daily tests was run on each puppy, making three tests per day for 28 days, or 84 total tests. In the second phase of the experiment the puppies were injected, then given an opportunity to eat milk from a pan before being placed with the mother to suck. In the second part 14 daily tests were done on each of the three dogs, or a total of 42 tests. The puppies were 4 days old at the beginning, and 49 days old at completion of the tests. The tests were done on consecutive days, except for three days when other duties interfered with the experiments. On these days the puppies were left with the mother.

Before each test the 3 puppies were separated from the mother and placed in a warm box in an adjoining room. The period of separation varied from 1 to 5 hours during the first part of the experiments, and from 3 to 24 hours in the last 14 days. During this latter time they were old enough to be placed on a longer schedule of separation, and this assured a stronger food drive for the eating behavior which followed injection of milk. After the period of separation, milk was injected via tube into the stomach, and after another interval the puppies were placed with the mother and allowed to suck. In the last part of the tests the puppies were injected, then permitted to lick milk from a pan, then placed with the mother and given opportunity to suck. In the early tests the amount of milk injected started at 13 grams and was gradually increased to around 80-90 grams. In the second part of the tests, when the puppies were older, the amount of milk injected started at 100 grams and was gradually increased to around 250 grams. The amount of milk injected was determined largely by the total amount the stomach would hold at the respective age. When the stomach is filled the milk runs out the mouth of the animal, and by experience one can soon judge just about how much the animal can hold. In order to determine how much milk was injected, how much consumed during sucking, or how much food taken in during eating, the puppies were weighed before and after each phase of the experiment.

The time interval between injection and sucking was varied from 5 to 15 minutes. In the last phase of the experiments the puppies were given opportunity to lick milk immediately after injection, then placed with the mother to suck.

Controls are already provided by a previous study which showed

that all puppies would suck after similar periods of separation (James, 1957a).

RESULTS

The results have been divided into four periods. The first presents the results of the first 10 days, the second the next 10 days, and the third the last 8 days of the period of injection followed by sucking. This gives a picture of the increase in food intake by sucking and decrease in sucking time as age increases. The fourth period presents the results of the last 14 days, in which injection was followed by opportunity for licking milk from a pan, and then by sucking.

The results are summarized in Table 1. The first part of the table shows that injection of milk did not eliminate sucking. This is the case even when the stomach is filled with more food than the puppies ever sucked under normal conditions. On most of these tests the animals

TABLE 1

SUMMARY OF SUCKING BEHAVIOR IN BOTH PARTS OF THE EXPERIMENT

Part I. Sucking Behavior after Injection of Milk

Total tests during first 3 periods of experiment	84
Total number times puppies sucked after injection	84 (100%)
Number of times animals gained weight after sucking	73 (86%)
Number times sucking with no gain in weight	11 (14%)

	First 10 Days	Second 10 Days	Last 8 Days
Mean gain in weight on sucking	9.2 gm.	14.3 gm.	17.1 gm.
Mean sucking time	14.4 min.	8.5 min.	6.2 min.

Part II. Sucking Behavior after Injection and Opportunity to Lick Milk from Pan

Total number of injections	42
Total number tests of licking after injection	42
Total number times animal drank milk after injection	23 (54.7%)*
Mean gain after licking	21.2 gm.
Total number times animals sucked after injection and opportunity to lick	42 (100%
Number times animals gained weight by sucking which followed injection and licking	38 (90%)
Mean gain after sucking	17.6 gm.
Mean sucking time	8.2 min.

*Previous tests have shown that if the stomach is filled to capacity the eating reflex is eliminated (James, 1957b).

gained weight, but in 14 per cent of the tests sucking occurred without gain in weight. In general, the sucking time decreases and milk intake increases as the puppies get stronger.

The last part of the table indicates that injection followed by consummatory licking does not eliminate sucking. The animals sucked in all tests following injection and consummatory licking. The animals

did not always take milk from the pan after injection, however, but in any case they would suck. A previous study has shown that if the stomach is filled to capacity, the eating reflex is eliminated in young puppies, but not sucking (James, 1957b). This seems to suggest that the mechanism for controlling eating is different from that which controls sucking. Stomach distension apparently does not cut off the sucking reflex, while there does not seem to be any doubt about its effect on food intake by licking and chewing (James, 1957b). The present experiment further confirms the conclusion that the sucking reflex is a dominant pattern of behavior unrelated to stomach content.

SUMMARY

A total of 84 tests were made on puppies to further examine the influence of stomach injected food on the sucking reflex. Sucking followed injection of milk in every case, even when the stomach was filled to capacity. In the great majority of tests the puppies gained weight after sucking, but in 14 per cent of the tests they sucked for rather long periods without gaining weight. In 42 additional tests injection was followed by opportunity for licking milk from a pan and then by sucking. In these tests also, the puppies sucked in every case. The puppies did not lick milk from a pan in every test, however, since it has been shown that if the stomach is filled to capacity, the licking and eating response is eliminated. Sucking seems to be a reflex occurrence which is independent of the amount of food in the stomach.

REFERENCES

BEACH, F. A. & JAYNES, J. Effects of early experience upon the behavior of animals. *Psychol. Bull.*, 1954, 51, 239-263.

DAVIS, J. V., SEARS, R. R., MILLER, H. C. & BRODBECK, A. J. Effects of cup, bottle and breast feeding on oral activities of new-born infants. *Pediatrics*, 1948, 3, 549-558.

HALVERSON, H. M. Mechanisms of early infant feeding. *J. genet. Psychol.*, 1944, 64, 185-223.

HALVERSON, H. M. A study of feeding mechanisms in premature infants. *J. genet. Psychol.*, 1946, 68, 205-217.

HOEFER, C. & HARDY, M. Late development of breast-fed and artificially fed infants. *J. Amer. Med. Assn.*, 1929, 92, 615-619.

JAMES, W. T. The effect of satiation on the sucking response in puppies. *J. comp. physiol. Psychol.*, 1957, 50, 375-378. (a)

JAMES, W. T. & GILBERT, T. F. Elimination of eating behavior by food injection in weaned puppies. *Psychol. Rep.*, 1957, 3, 167-168. (b)

LEVY, D. Experiments on the sucking reflex and social behavior of dogs. *Am. J. Orthopsychiat.*, 1934, 4, 203-224.

ORLANSKY, H. Infant care and personality. *Psychol. Bull.*, 1949, 46, 1-48.

ROGERSON, B. C. F. & ROGERSON, C. H. Feeding in infancy and subsequent psychological difficulties. *J. Ment. Sci.*, 1939, 85, 1163-1182.

ROSS, S. Effects of early weaning on sucking behavior of Cocker Spaniel puppies. *Anat. Rec.*, 1951, 111, 492. (a)

ROSS, S. Sucking behavior in neonate dogs. *J. abnorm. soc. Psychol.*, 1951, 46, 142-149. (b)

ROSS, S., FISHER, A., & KING, D. Sucking Behavior: A review of the literature. *J. genet. Psychol.*, 1957, 91, 63-81.

The Psychological Record, 1959, 9, 7-10.

PERSPECTIVES IN PSYCHOLOGY
IX. LITERATURE AS ART AND AS KNOWLEDGE[1]

PAUL SWARTZ
University of Wichita

Satisfactory resolution of the problem of method in psychological work depends, in part, upon achieving an adequate understanding of the basic historical factors involved. Different approaches to the study of human behavior mirror different conceptions of man, and these in turn develop in response to the changing ideological needs of social life. All sciences evolve in the crucible of historical determination, but in those in which the human being is the primary object studied the influence is greatest. The changing currents of social reality each presume, and require for their justification, a particular conception of man. Invariably absolute, these images coexist in history in an unstable hierarchy of ideological dominance, paralleling the structure of the underlying social reality. Only rarely, in times of great social stability or when social reality is a relatively homogeneous unit, does a single image achieve undisputed, long-lived dominance. It then becomes the polestar in the cultural firmament, and within the limits imposed by the level of general scientific and technological achievement reached by society, determines almost exclusively the course of inquiry into the nature of man.

Western psychology, ever since the decline of the objective Greek viewpoint, has developed largely under the influence of a dualistic conception of man. This is the image which rose to ascendancy in the church-dominated medieval world, a world, as Russell (1945, p. 302) points out, of various forms of dualism, "the dualism of clergy and laity, the dualism of Latin and Teuton, the dualism of the kingdom of God and the kingdoms of this world, the dualism of the spirit and the flesh," . . . all "exemplified in the dualism of Pope and Emperor." Medieval psychology was a religious psychology. To the medieval philosopher, writes Professor Burtt (1954), the religious experience "was the crowning scientific fact."

> Reason had become married to mystic inwardness and entrancement; the crowning moment of the one, that transitory but inexpresssibly ravishing vision of God, was likewise the moment in which the whole realm of man's knowledge gained final significance. The world of nature existed that it might be known and

1 The larger part of this paper was presented at the Symposium of Division 10 of the American Psychological Association in Washington, D. C., on September 1, 1958.

> enjoyed by man. Man in turn existed that he might "know God and enjoy him forever" (pp. 19-20).

The medieval hunger for God found its psychological expression in a preoccupation with the human soul. When St. Augustine wrote, on the threshold of the medieval era, "I desire to know God and the soul," he was "directly formulating," to use Brett's phrase (1953), "the scope of psychology for many succeeding centuries." In the scholastic synthesis of St. Albert and St. Thomas in the thirteenth century the search for God and the soul reached its culmination.

Medieval psychology was an appendage of medieval theology. Its methods of inquiry were those of the theologian. Faith in the power of reasoning as a source of knowledge was the cardinal tenet of the medieval psychologist. Especially in the period of scholasticism, with its emphasis on syllogistic reasoning and dialectic, and its disdain for observation, is the rationalistic character of medieval psychology clearly in evidence. The scholastic method "is the academic method in its perfection," writes Brett:

> encyclopaedic learning, and astounding subtlety are the marks of the great medieval champions: they can quote, defend, pervert and controvert with all the baffling dexterity of intellectual fencing (1953, p. 247).

The dualistic conception of man survived the dissolution of the medieval world and endures in the modern period as an inherent feature of the Judaeo-Christian tradition. Its influence on general psychological thinking is, of course, considerably diminished, and it is in competition with more process oriented definitions of man. In the behavioristic model of biological reductionism dualism has been "stood on its head," so to speak. "Biological Man" has replaced "Spiritual Man" as the focus of inquiry. "In modern psychology," writes Professor Hebb, "mind is considered to be some part or aspect of brain activity—though this is held only as a working assumption—and is studied by objective methods" (1958, p. 17).

Whether or not we agree with Hebb (1958, p. vii), that "psychology is fundamentally a biological science," there is no gainsaying the fact that biologically oriented thinking has had a very powerful and initially liberating effect on modern psychology. Experimental psychology emerged in the nineteenth century under the impact of a flourishing experimental physiology. The remarkable achievements of experimental method in the biological sciences constitute, in fact, one of the principal "historical justifications" for the application of this method to the study of behavior.

A knowledge of history, it can be argued, introduces the possibility of softening its tyranny. Although we recognize that this argument may be but a snare and a delusion, we are going to use it as our working assumption in elaborating upon a suggestion made by this

writer in a previous paper (Swartz, 1958), namely, to introduce intentionally, as a supplement to more scientifically acceptable knowledge, observations of behavior found in literature as bona fide data for psychology in hypothesis and theory construction.

The conception of literature as data to be used inductively in psychological work acquires meaning only as we are successful in distinguishing between literature as art and literature as knowledge. This is a problem that must be discussed from two points of reference. With the writer in focus the problem is one of analyzing non-systematic, reflective observation as a knowing event, and of delineating the witting or unwitting use of knowledge derived in this process in the craft of constructing a product possessing aesthetic merit. Considered from the standpoint of the reader the problem is one of defining perspectives. To read a book as a psychologist, with primary regard for the validity of the reality underlying the illusion, requires a set of disciplined, critical attitudes that are not wholly compatible with reading simply as an aesthetic experience. In making this distinction, it should be noted, we do not mean to deny that there is an aesthetic dimension or component in reading a work as a psychological study. On the contrary, it is necessary as a psychologist to participate empathically in the writer's illusion if the psychological insights recovered are to be grasped in their fullest significance. The psychological perspective in reading, then, can be described as one of controlled empathic participation, in which the primary intent of the reader is not to derive aesthetic pleasure but to extract the writer's observations of behavior as possible contributions to the body of validated psychological knowledge.

A defense of literature as a means to valid knowledge has recently been brilliantly made by Wallace Stegner (1958). "Possibly," he writes,

> the arts may be very often merely entertaining, remote from the profounder truth, and entangled in ritual. But at their best they are a perfectly valid instrument of knowledge: knowledge of things *as experienced,* knowledge of which both observed and observer make a part (p. 10).

In art, declares Stegner, quoting Albert Camus, "'a profound thought is in a constant state of becoming. It adopts the experience of a life and assumes its shape'." Rephrasing this observation he suggests:

> Any work of art is the product of a total human being commenting with his total understanding on experiences that with luck may become symbolically representative of larger experience, even of all experience (p. 43).

The truth of art, finally,

> is conceptualized in the union of work and reader; it is an insight communicated by example from writer to reader . . . it inevitably takes some coloration from

> the reader's temperament and state of mind and cultural background. It is a collaboration, a meeting of minds and spirits, a thing that lights up like love (pp. 10-11).

The conception of literature as knowledge that Stegner develops does not, of course, commit him to a conception of literature as psychological data. The latter concept presupposes the verifiability of artistic insights into human behavior. This assumption, Stegner explicitly rejects. Art, he maintains, in contrast to experimental method, "gives up any claim to verifiability, gives up limited and controlled truth, in exchange for its truth-in-context, truth by confrontation and recognition . . ." It is in "the response," the "aesthetic experience," that "the proof of art" is to be found. Heroically, he defends the province of art against the "philistine" invaders who would treat it as "'subject matter'" or attempt to reduce it "to the laws and the orderliness that are the ideal and monumental strength of science."

The conflict between the approach to literature proposed by the present writer and the conception advanced by Stegner is readily apparent, both in regard to the question of verifiability and to the problem of reader perspective but it should not be exaggerated. We have already suggested in a previous paper (Swartz, 1958) that literary insights and observations are probably not susceptible to direct experimental validation. The prospects for clinical verification, we noted, seem much brighter. The best procedure, it was opined, for validating literary insights is "to determine how well our understanding, prediction, and control of other observational events is improved through the use of this knowledge."

The problem, now, is sharply in focus. Is it possible to validate literary insights without reducing literature to "law and order," without destroying the integrity of literature as an art-form? A truly pluralistic approach to the understanding of human behavior based on a body of verified psychological knowledge requires just this. Time and work alone will reveal whether the problem of verification in the arts is inherently insoluble or simply an historical artifact.

REFERENCES

BRETT, G. S. *History of psychology.* New York: Macmillan, 1953.

BURTT, E. A. *The metaphysical foundations of modern science.* Garden City: Doubleday, 1954.

HEBB, D. O. *A textbook of psychology.* Philadelphia: W. B. Saunders, 1958.

RUSSELL, B. *A history of western philosophy.* New York: Simon & Schuster, 1945.

STEGNER, W. One way to spell man. *Sat. Rev.,* 1958, 41, No. 21.

SWARTZ, P. The criteria of validity in observational analysis. *Psychol Rec.,* 1958, 8, 77-85.

The Psychological Record, 1959, 9, 11-18.

ACQUISITION OF A SIMPLE RUNNING RESPONSE AS A FUNCTION OF PARTIAL AND CONTINUOUS SCHEDULES OF REINFORCEMENT[1]

DONALD F. HAGGARD

State University of Iowa [2]

The results of experimental studies concerning the effects of variations in the reinforcement schedule on the acquisition of conditioned responses have been highly conflicting, varying not only from one type of conditioning situation to another, but also among studies that have employed the same situation. In an extensive review and critique of the studies conducted prior to 1950, Jenkins and Stanley (1950, p. 209) summarized their conclusions with respect to the comparison of acquisition under partial and continuous schedules of reinforcement as follows: "Overall, it can be said with considerable assurance that *acquisition proceeds somewhat more rapidly and reaches a higher final training level under continuous reinforcement than under partial reinforcement.* With prolonged training partially reinforced groups may approach the same level of proficiency attained earlier in training by continuously reinforced subjects."

Examination of the summarizing table given by these writers revealed that this conclusion was based on only three studies that involved instrumental reward conditioning. Two of these studies, Finger (1942 a; 1942 b), did indicate that the 100% reinforced animals ran significantly faster, over 16 acquisition trials, than those receiving 50% reinforcement. In the third study, Sheffield (1949) actually showed no difference between the 50% and 100% reinforcement groups over 30 acquisition trials. This experiment was complicated, however, by the fact that all S's were first given ten pre-training trials in which a 100% reinforcement schedule was employed.

Two later studies (Lewis, 1956; Wilson, Weiss & Amsel, 1955) essentially duplicating the Sheffield apparatus and procedure, indicated that the 100% reinforced animals ran somewhat faster than those receiving 50% reinforcement during the 30 trial acquisition period. These findings are in accord with those of Finger (1942 a; 1942 b) in substantiating the Jenkins and Stanley conclusion.

Contrary to these findings, the results of a study by Rubin (1953) indicated that the 100% and 50% reinforcement groups were about equal in performance at the end of a 32 trial training period. This would tend to corroborate Sheffield's results (1949).

1. This article is based on a dissertation submitted to the faculty of the department of psychology of the State University of Iowa in partial fulfillment of the requirements for the Ph.D. degree. The writer is greatly indebted to Dr. K. W. Spence for valuable aid and advice offered throughout the course of the experiment.

2. Now with the Human Resources Research Office, George Washington University.

In comparing these two apparently conflicting sets of studies attention should be directed to the fact that the acquisition periods have involved only 16 to 32 training trials. Considerable evidence has since been obtained which indicates that this number of trials represents only a small portion of the total training period required to attain complete learning, i.e., the performance asymptote.

Fortunately, several studies that present data for more extended acquisition periods have recently become available. In one of these experiments, Taylor (1953) studied the acquisition of a stepping response from a runway to a separate platform. Speed of acquisition curves for 50 trials showed a gradual divergence between trials 6-26, the 100% reinforcement group responding more quickly than the 50% reinforcement group. Statistical analysis, by the author, of trial blocks 10-15, 16-20, and 20-25 revealed the performance of the 100% reinforcement animals to be significantly faster for blocks 16-20 and 20-25 ($p<.05$). At trial 30 the two curves came together and remained so until trial 50. Unfortunately only the 50% group was run beyond this point and its curve had not yet become asymptotic at 100 trials.

In the second study, Weinstock (1954) compared running speeds in an L-shaped runway using 30, 50, 80 and 100% schedules of reinforcement. Examination of the acquisition curves revealed the 100% reinforced group to be somewhat above those of the other three groups during the early portion of training (trials 6-15). However, after trial 30 the curves for the 30 and 80% group were consistently, but not significantly, above that of the 100% group until the end of the 75 trial acquisition period.

Thus the data from these latter studies suggest an initial superiority of the 100% reinforcement group for a period approximating the total training time of earlier studies. It is important to note, however, that this superiority is not maintained and the performance curves converge near the end of this period. The apparent conflict in earlier results might thus be related to the extent of the to-be-learned response curve included in the acquisition period. Furthermore, the evidence suggests that partially reinforced groups may perform at a level at least equal to, and possibly higher than, the 100% reinforced groups if training is continued to the performance asymptote.

The purpose of the present study was to compare the performance, in an instrumental reward situation, of a partially reinforced group (50%) with that of a group receiving 100% reinforcement over an extended period of training. Based on the indications of previous studies, particular attention was focussed on the relation obtaining between the performance of the two groups during the early portion of training (trials 1-24) and at the performance asymptote.

METHOD

Subjects

The Ss were 46 experimentally naive hooded rats from the colony maintained by the psychology department of the State University of Iowa. The ages at the beginning of the experiment were approximately 160 days.

Apparatus

The apparatus used was a wooden, straight-alley maze, 4½ in. wide and 5¾ in. high throughout. The starting box was 15 in. long and painted a flat grey. The runway was 36 in. long and painted flat black. Two guillotine-type doors separated the starting box from the runway proper: first, a thin brass door painted grey on the starting box side and flat black on the runway side; second, a ¼-in. clear plastic door. The goal box, 15 in. long and painted flat black, was separated from the runway by a guillotine-type fibreboard door painted flat black on both sides. A microswitch connected to the door illuminated the goal box only when the door was closed. The entire maze was covered with ¼-in. clear plate glass. This glass was painted flat black over the final 6 in. of the runway. A fibreboard shield, 36 in. wide, 48 in. high and painted flat black, separated the runway and goal box areas. The painted glass and shield blocked stray illumination from entering the goal box, thus preventing S from perceiving the contents of the goal box while in the runway.

Raising the plastic start box door closed a microswitch activating a Standard Electric Timer. Breaking the light beam to a photocell located 12 in. beyond the plastic door stopped the first timer and activated a second Standard Electric Timer. Breaking the light beam to a photocell located 24 in. beyond the plastic door stopped the second timer. Both photocell bulbs were shaded with infra-red filters. The photocells and bulbs were attached to the outside surface of the runway walls and the light beams focussed through ½-in. diameter holes centered 2 in. above the runway floor. All circuits used Hunter silent relays. Standard Electric Timers measured to 1/100 sec.

Three waiting cages, 10 in. long, 4 in. wide, and 3½ in. high, were constructed of natural wood and covered with hardware cloth.

Procedure

Handling and drive rhythm. The Ss were handled for a minimum period of 10 days prior to the beginning of the experiment. During this period a 24-hr. drive cycle was established. Each S was fed for a 1-hr. period after 23-hrs. food deprivation. Individual feeding cages were used and more than sufficient amounts of Purina Lab Chow were kept in the cages. Fresh water was available at all times in both the feeding and home cages. This feeding rhythm was continued throughout the experiment.

Habituation. On each of the two days prior to the beginning of the experiment S received six direct feedings in the goal box. Each S received five 45-mg. Purina Lab Chow pellets for each of the first four feedings and ten pellets for each of the remaining eight feedings. These pellets were used for all subsequent pre-feeding and reinforcement in the learning situation.

Training. Ss were run daily, in squads of six to nine, during two separate calendar periods: 14 Ss during the first period and 32 Ss during the second period. Prior to the first trial of each day S received one direct feeding of two pellets in the goal box. Each S received six training trials per day with a minimum inter-trial interval of 20 mins. and at an average of 23-hrs. food deprivation. Each reinforcement during the training trials consisted of five pellets. A total of 90 trials were given in 15 consecutive days.

For each calendar period the Ss were randomly assigned to one of two experimental groups: 100% reinforcement ($N=23$) or 50% reinforcement ($N=23$). The 100% reinforcement group was reinforced on all trials. The 50% reinforcement group was reinforced on a random one-half of the trials for each day and non-reinforced on the other one-half.

On all trials the goal box was illuminated immediately after S entered it. All Ss were removed from the apparatus 15 sec. after entering the goal box. Following reinforced trials S was placed directly in the carrying cage. Following non-reinforced trials S was placed directly in the waiting cage for approximately 3 min. He was then placed in the carrying cage and immediately fed five pellets.

The purpose of the waiting cage was to eliminate secondary reinforcement by the carrying cage as some animals tended to store pellets in their pouch until placed in the carrying cage. Feeding in the carrying cage following non-reinforced trials was intended to equalize the groups in the total food intake prior to each trial.

RESULTS

Two measures of performance were utilized: evocation speed (the reciprocal of the time required to traverse the initial 12 in. of the runway) and running speed (the reciprocal of the time required to traverse the second 12 in. of the runway).

To test for initial differences in the performance levels of the two reinforcement groups a two factor analysis of variance, reinforcement condition by calendar period, was computed separately for evocation speeds and running speeds. The analyses were based on the mean speed of the first three trials of each animal. A non-reinforcement did not precede any of these three trials. No reliable differences between the two reinforcement groups were indicated.

The mean evocation and running speeds for successive blocks of

six trials are plotted in Fig. 1. It can be seen that, for both speed measures, the curve for the 100% group is above that of the 50% group

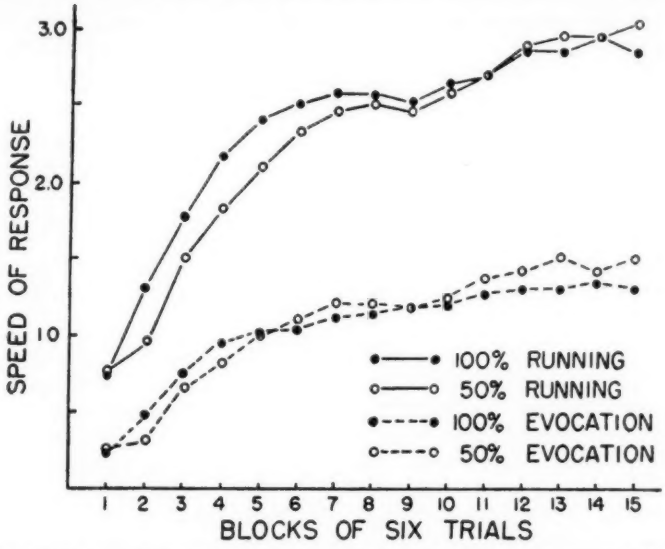

Fig. 1. Mean speed of response (1/response time) for the 100% reinforcement and 50% reinforcement groups plotted over blocks of six trials.

during the initial phase of training. However, the curves later converge and during the final phase of training, the 50% group shows greater evocation speeds than the 100% group and at least equal running speeds.

For each performance measure, separate statistical analyses were computed for the first four blocks of trials (trials 1 to 24) and the last three blocks of trials (trials 73 to 90). The selection of these particular trial blocks was based on the results cited for previous studies. Each analysis (Lindquist, 1953, Type III design) included reinforcement conditions, trial blocks, and calendar period. None of the analyses showed a significant calendar period interaction with either reinforcement conditions or trial blocks, so no further reference will be made to the calendar period variable.

The results of the analyses of the first four blocks of trials indicated that the observed difference in the evocation speeds of the two reinforcement conditions was not significant ($p>.05$). The reinforcement conditions by trial blocks interaction was also non-reliable ($p>.05$). However, for the running speed measure a significant interaction between reinforcement conditions and trial blocks ($p<.025$) indicated a reliable difference in the rate of acquisition for the two reinforcement conditions.

The results of the analyses of the final three blocks of trials indi-

cated that the evocation speed of the 50% group was significantly greater than that of the 100% group ($p<.01$). With regard to the running speed measure there was no reliable difference between the reinforcement conditions ($p>.05$). Neither measure showed a reliable difference between trial blocks ($p>.05$) or a significant interaction ($p>.05$). This would indicate that both groups were approaching the performance asymptote when training was terminated.

In summary, during the initial phase of training (trials 1 to 24) the observed superiority of the 100% reinforcement group over the 50% reinforcement group was statistically reliable only for the running speed measure. Near the performance asymptote (trials 73 to 90) the running speed measure indicated equal performance under the two reinforcement conditions while the evocation speed measure showed a significantly higher level of performance for the 50% reinforcement group.

DISCUSSION

The present experiment obtained results that tend to be in agreement with the two apparently conflicting sets of previous investigations. Previous studies (Finger, 1942 a; Finger, 1942 b; Lewis, 1956; Wilson et al., 1958) that have shown superior performance on the part of 100% reinforced subjects, as compared to partially reinforced subjects, have involved a relatively few number of trials (16 to 30). In line with the findings of these studies, the present experiment tended to show superior performance on the part of the 100% reinforcement group during the first 24 trials. On the other hand, previous studies (Rubin, 1953; Sheffield, 1949; Taylor, 1953; Weinstock, 1954) that have shown no difference between groups run under partial and 100% schedules of reinforcement have extended training over a sufficiently long period to approach the asymptote of performance. In line with the findings of these studies, the present experiment indicated that near the asymptote of learning there was either no difference or, as in the case of the response evocation measure, the partial group was superior. It would thus appear that these apparently conflicting results were simply a function of the number of training trials.

With regard to the performance asymptote the data are not entirely conclusive. It is clear that with extended training the performance of the 50% reinforced group reached a level at least equal to that of the 100% reinforcement group. Beyond this the data are conflicting. The evocation measure showed a higher level of performance for the 50% group but the running measures remained equal. In this connection it may be noted that the evocation curves converged relatively early in training while the running curves did not come together until much later. An examination of these curves also indicates that the evocation measures were at, or very near, their asymptote while the running measures were possibly still increasing at the termination of training. Whether the partial group would have reached a higher final level of

running speed had training been continued cannot be determined from this study. It is possible that the relationship between the performance asymptotes of partial and 100% reinforcement groups varies with the portion of the to-be-learned response chain that is measured.

While the purpose of this study was primarily empirical, it is interesting to note the degree of correspondence of the results to the predictions that may be made from two recent formulations.

Weinstock (1954) has postulated, that competing responses made to an empty goal box on a nonreinforced trial are conditioned to the goal box stimulation and are later elicited by the similar runway stimulation. This results in a decrement in performance. On the basis of his observations he further assumed that these responses tend to habituate so that the amount of decrement in later learning becomes small. Accordingly, Weinstock predicts "a direct relation between percentage of reinforcement and asymptotic speed." (p. 321). While the results of this study confirm the notion of an initial decrement in performance, they do not substantiate the predicted relation between the final performance levels. In fact, this portion of Weinstock's hypothesis was not substantiated by his own data. Whether the final level of the partial groups is equal to or greater than that of the 100% group, the present result would not be predicted from Weinstock's formulation.

The possible operation of another mechanism has been suggested in articles by Amsel (1958) and Wilson, Weiss, and Amsel (1955). They propose that frustration results from an interaction between nonreward and a fractional anticipatory goal reaction that develops during the early rewarded trials. The runway stimuli are then conditioned to a fractional anticipatory frustration response. The stimuli resulting from this response elicit responses previously conditioned to them and also lead to an increased drive level. Initially, responses evoked by the frustration stimuli interfere with the to-be-learned running response, but with continued reinforcement of the running response, they become conditioned to it. The results of the present study tend to confirm the predictions that would be made from the operation of such a mechanism. The lower level of performance of the 50% reinforcement group early in training could be due to the occurrence of competing responses elicited by the anticipatory frustration stimuli. Likewise, the final level of performance of this group might be attributed to a greater drive level and/or to a greater stimulus complex than that available to the 100% reinforcement group.

SUMMARY

The purpose of the present experiment was to compare rates of acquisition of a simple running response under schedules of 100% and 50% reinforcement. Forty-six male hooded rats, divided randomly into two equal groups, were given 90 trials in a black runway. Each animal received six spaced training trials per day for 15 consecutive days. The

100% reinforcement group was reinforced on all trials. The 50% reinforcement group was reinforced on a random one-half of the trials for each day and non-reinforced on the other half.

Analyses of both an evocation speed and a running speed measure indicated that the 100% reinforcement group was responding more quickly than the 50% reinforcement group over approximately the first 24 trials although this difference was statistically reliable only for the running speed measure. Later in training the performance curves of the two reinforcement groups converged and during the final trials the 50% reinforcement group showed a reliably higher level of performance in evocation speed and equal performance in running speed.

These results were discussed in relation to several alternative formulations of the possible mechanism producing such behavior. It was concluded that the operation of an anticipatory frustration response would best explain behavior during the entire period of training.

REFERENCES

AMSEL, A. The role of frustrative nonreward in noncontinuous reward situations. *Psychol. Bull.*, 1958, 55, 102-119.

FINGER, F. W. The effect of varying conditions of reinforcement upon a simple running response. *J. exp. Psychol.*, 1942, 30, 52-68. (a)

FINGER, F. W. Retention and subsequent extinction of a simple running response following varying conditions of reinforcement. *J. exp. Psychol.*, 1942, 31, 120-133. (b)

JENKINS, W. O., & STANLEY, J. C. Partial Reinforcement: A review and critique. *Psychol. Bull.*, 1950, 47, 193-234.

LEWIS, D. J. Aquisition, extinction and spontaneous recovery as a function of percentage of reinforcement and intertrial intervals. *J. exp. Psychol.*, 1956, 51, 45-53.

LINDQUIST, E. F. *Design and analysis of experiments in psychology and education.* Boston: Houghton Mifflin, 1953.

RUBIN, L. S. A demonstration of superior resistance to extinction following continuous reinforcement as compared with partial reinforcement. *J. comp. physiol. Psychol.*, 1953, 46, 28-32.

SHEFFIELD, V. F. Extinction as a function of partial reinforcement and distribution of practice. *J exp. Psychol.*, 1949, 39, 511-526.

TAYLOR, J. E. The effects of differential positive-negative cue differences on the changing strength of response tendency. Unpublished doctoral dissertation, State University of Iowa, 1953.

WEINSTOCK, S. Resistance to extinction of a running response following partial reinforcement under widely spaced trials. *J. comp. physiol. Psychol.*, 1954, 47, 318-322.

WILSON, W., WEISS, I. J., & AMSEL, A. Two tests of the Sheffield hypothesis concerning resistance to extinction, partial reinforcement and distribution of practice. *J. exp. Psychol.*, 1955, 50, 51-61.

The Psychological Record, 1959, 9, 19-28.

DELAYED REINFORCEMENT AND RUNWAY PERFORMANCE[1]

EDWARD L. WIKE AND WALTER KINTSCH

University of Kansas

Although the effects of delay of reinforcement have been studied for some time (Watson, 1917), research in the last decade has taken three new directions: first, to ascertain whether delayed reward affects habit formation or performance (Spence, 1956); second, to discover the effects of delay during training upon resistance to extinction (Fehrer, 1956); and third, to study the consequences of partially delayed reinforcement, i.e., where delay of reinforcement occurs on a fraction of the training trials with the remaining trials being immediately reinforced. Since the present studies are primarily concerned with the third issue, a brief review of the experiments on partially delayed reinforcement and runway performance is presented below.

In 1951, Crum, Brown and Bitterman, in the course of testing Sheffield's generalization-decrement theory of intermittent reinforcement, investigated the role of partially delayed reinforcement in instrumental conditioning. They found that when rats were subjected to goal box delays of 30 sec. on 50 per cent of the training trials, they learned as readily and withstood extinction longer than Ss which had been rewarded without delay on all training trials.

Scott and Wike (1956) replicated the experiment of Crum, Brown and Bitterman and, in addition, varied the factor of trial-distribution. While the findings of the original investigators were fully confirmed, massing the trials with a 15-sec. intertrial interval and spacing the trials every 15 min. during both acquisition and extinction failed to produce any differential effects.

Logan and his co-workers (Logan, Beier & Ellis, 1955; Logan, Beier & Kincaid, 1956) have reported two runway experiments involving delay. In the first study Ss were rewarded after a 1-sec. delay (preferred delay group), after a 1-sec. delay on half of the trials and 9-sec. delay on the remaining half (varied delay group), or after a 5-sec. delay (mean delay group). In both training and extinction Ss received a single trial daily. The mean delay group had slower running times in acquisition than the other two groups, which did not differ from each other. The extinction results were in marked contrast to the findings of Crum, et al (1951) and Scott and Wike (1956)—neither the rates

1 Supported by General Research Fund, University of Kansas.

of extinction nor the asymptotic extinction levels differed among the three groups.

To clarify these conflicting extinction results a second experiment (Logan, et al, 1956) was performed in which massed training with a 15-sec. intertrial interval was used. Three delay conditions were imposed: 0-sec. delay group; 0-and 9-sec. varied delay group; and 0-and 30-sec. varied delay group. No results for the acquisition period were indicated, but the 0-30 sec. varied delay group displayed the greatest resistance to extinction, while the 0-sec. and 0-9 sec. groups extinguished at the same rate. This study suggests that the duration of delay is an important factor in producing greater resistance to extinction.[2]

As a part of a larger investigation, Peterson (1956) compared the runway behavior of a group with immediate reward and a group that was detained for 0, 10, 20, and 30 sec. in a random order during training. The varied delay group was significantly retarded in learning, but required almost twice as many trials as the non-delay group to obtain an extinction criterion.

Finally, Wike and McMamara (1957) observed the effects of the percentage of partially delayed reinforcements on a runway response. A group that had been delayed for 30 sec. on 25-per cent of the training trials ran faster at the termination of training than did groups which had been delayed on 50- and 75-per cent of the trials. However, in extinction the latter two groups ran significantly faster than the 25-per cent delay group.

Combining the results of these six experiments, two provisional generalizations can be made:

1. Delay of reinforcement on a fraction of the training trials does not retard the acquisition of an instrumental response in contrast to the performance with continuous immediate reinforcement.

2. Delay of reinforcement on a fraction of the training trials results in greater resistance to experimental extinction than that after training with continuous immediate reinforcement.

There are two exceptions to the first generalization. In Peterson's experiment the retarded acquisition performance of the variable delay group may have resulted from the high percentage of delays. In the Wike and McNamara experiment the slower running of the 50- and 75-per cent delay groups may have been due to the fact that a separate delay box was used, thus preventing Ss from being rewarded secondarily to as great a degree within the delay periods (Spence, 1956). It should be emphasized that this was the only runway experiment in which Ss were not detained in the goal box itself.

The sole exception to the second generalization occurs in Logan's first experiment. This deviant extinction result may be attributed to

2 This conclusion has been confirmed in a T maze (Kintsch & Wike, 1957).

either the short variable delay period of 9 sec. or to the lengthy 24-hr. intertrial interval that was present in Logan's design. In regard to the latter factor, it is important to note that in all other experiments the time between trials has ranged from 15 sec. to 15 min.

The main purpose of the present experiments was to determine whether 20-sec. delays of reinforcement on 0-, 20-, 50-, 80-, and 100-per cent of the training trials influence response speeds in acquisition and extinction under the condition of widely distributed (24-hr. intertrial interval) trials. In Exp. 1 Ss were confined during the delays in a separate delay chamber, and two additional delay groups which were delayed 10, 20, and 30 sec. in a random order on 50- and 100-per cent of the training trials are included. In Exp. 2 the five 20-sec. delay groups were confined in the goal box. These experimental conditions should also provide an answer to the question posed by the unusual extinction results in Logan's first experiment, information on the effects of 100-per cent delay upon resistance to extinction, and data regarding the consequences of constant 20-sec. delay intervals vs. variable 10- to 30-sec. delay intervals.

EXPERIMENT 1

Method

Subjects

The Ss were 46 experimentally naive female Sprague-Dawley rats of approximately 70 days of age. They were obtained from the Sunset Hills Farm of Lawrence, Kansas. The Ss were randomly assigned to the seven experimental treatments and eight Ss were discarded when they failed to run or eat on five occasions during the first 10 trials. The number of Ss completing the experiment were: Group 0, $n=3$; Group 20, $n=6$; Group 50 $n=5$; Group 50 V, $n=6$; Group 80, $n=7$; Group 100, $n=5$; Group 100 V $n=5$. These treatments are specified in detail under Procedure.

Apparatus

A black wooden 7.67-ft. alley type runway was used. It had a light gray 8-in. by 5-in. by 6-in. starting box, the last 12-in. of the runway served as a delay box, and a dark gray 9-in by 12-in. by 6-in. goal box was attached to the end of the maze. Three guillotine doors controlled S's progress through the maze: door A separated S from the runway; doors B and C confined S to the delay box; door C gave S access to the goal box. The entire apparatus was covered by hardware cloth, and was illuminated by two 90-w. fluorescent tubes, which were located 6-ft. overhead and 3-ft. to the right of the maze. Throughout the experiment running times—the time between the elevation of the starting box door and S's entrance into the delay box—were taken by a manually operated Standard timer.

Procedure

On the first four days each S was gentled for 1 min. per day and adapted to a 22-hr. hunger cycle by feeding it Purina Layena pellets for 1 hr. daily in the home cages which were located in the same room as the apparatus. Water was always available in these cages.

On Days 5 and 6 each group of six or seven Ss was given group exploration in the runway for 10 min. All doors were in the up position, a glass furniture coaster filled with Purina pellets was placed in the goal box, and Ss were removed from the runway at the goal box. Following exploration Ss were fed for 1 hr. in their home cages.

The succeeding 40 days constituted the acquisition period in which Ss received one trial daily under the appropriate conditions of delay. The Ss in Group 0 were never delayed. The Ss in Groups 20, 50, 80, and 100 were delayed for 20 sec. on 20-, 50-, 80-, and 100-per cent of the trials. The Ss in Groups 50 V and 100 V were delayed for 10 sec., 20 sec., and 30 sec. in random order on 50- and 100-per cent of the trials. The occurrence of delays was determined by a table of random numbers for 10-trial blocks with the restriction that the first trial was always rewarded immediately except for Groups 100 and 100 V. Each S had a different delay pattern in order to randomize the influence of the pattern. The Ss in Group 50 V had two 10-sec. delays, two 30-sec. delays, one 20-sec. delay, and five 0-sec delays in each 10-trial block, while Ss in Group 100 V experienced four 10-sec. delays, four 30-sec. delays, and two 20-sec. delays.

In acquisition the order in which the groups were tested varied randomly from day to day. Fifteen min. after a group finished its trials, Ss were fed for 1 hr. in the home cages. During the first 10 trials Ss had 2 min. in which to enter the delay chamber. If S did not conform to this criterion, it was placed in the chamber by *E*. After the first 10 trials this criterion was reduced to 1 min. The S had 20-sec. feeding after it entered the goal box.

The Ss underwent 20 extinction trials after acquisition. One trial per day was administered, the delay box doors were always up, and S was confined in the empty goal box for 20 sec. The schedules of running and the home cage feeding procedures were identical to those described for the acquisition phase. As in the latter part of acquisition, if S failed to run within 1 min., it was placed in the goal box by *E*.

Results

The results of the experiment are shown in Figure 1. Each running time was rounded to the nearest whole sec. and transformed into a reciprocal. The basic response score for S was the sum of its transformed scores for five trials. The means of these basic response scores are plotted in Figure 1.

The initial equality of the groups was assessed by a simple analysis of variance for the first block of five trials. Although Groups 50 V and 100 V appeared faster at the outset of the experiment, the variation was fully within the limits of random sampling: $F=1.99$; $df=6,31$; $P>.05$.[3]

The entire acquisition period was evaluated by a simple analysis of variance. The difference between groups ($F=5.67$; $df=6,31$) was found to be significant beyond the .001 level. Next, a simple analysis of variance was performed upon the speed scores for trials 36-40 with

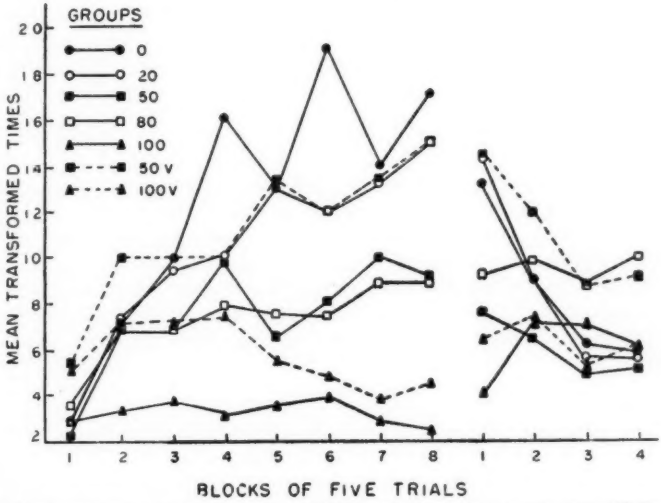

Fig. 1. Mean reciprocal running times in acquisition (blocks 1-8) and extinction (blocks 1-4) for Exp. I.

the result that the groups differed significantly ($F=7.02$; $df=6,31$; $P<.001$). The interpretation of this analysis was complicated, however, by the fact that the variances were not homogeneous ($.05>P>.02$). In view of recent evidence on the effects of heterogeneity of variance upon the probability values for the F-test, we have followed Lindquist's advice (1953, p. 86) of still employing the F-test, but of setting a higher level of significance throughout; namely, regarding differences to be significant only if the .01 level or less was achieved. It might be noted also that a non-parametric analysis of variance, the Kruskal-Wallis test, likewise led to the rejection of the null hypothesis. $H=22.50$; $df=6$; $P<.005$. To localize the differences at the termination of training, trials 36-40, Duncan's tests of means based upon unequal n's were performed.[4] Groups 0, 50 V, and 20 ran faster than Groups 100 and 100 V. All of these six differences were significant at less than the .01 level. The general trend in the results is clear—higher percentages of delay

3 In all analyses of variance, unless it is stated otherwise, the tenability of the assumption of homogeneity of variance was established by Bartlett's test.

4 We wish to thank Dr. David B. Duncan of Florida State University for making this unpublished modification of his technique available (Duncan, 1955).

are associated with slower running. Only Group 50V deviated from this trend by being as fast as Group 20.

The speed scores for the last block of trials in extinction were assessed by a simple analysis of variance. It was found that the differences between groups were not statistically significant: $F=1.63$; $df=6,31$; $P>.05$.

EXPERIMENT 2

Method

Subjects

Forty-five 100-day old rats of the same kind and source as those in Exp. 1 served as Ss. Nine Ss were assigned by a table of random numbers to each of the five delay conditions. None of Ss was discarded during the experiment.

Apparatus

The runway apparatus was modified by removing guillotine door B, and forming a food compartment in the final 2-in. section of the goal box by erecting a wall with a 4-in. wide guillotine door located in its center. The Ss were delayed in the goal box, and were permitted access to the food by raising the food compartment door. A Lab-Chron timer was used in place of the Standard timer. The S's home cages were in another room. In all other respects, the apparatus was the same as in Exp. 1.

Procedure

The first four days of adaptation were identical to those of Exp. 1. On Days 5, 6 and 7 the Ss explored the runway for 10 min. in groups of nine Ss, four or five Ss, and two or three Ss, respectively. The food compartment was filled and accessible on these trials. On Days 8, 9, and 10 each S received one immediately-rewarded runway trial. The Ss had 5 min. in which to enter the goal box and a 3-min. feeding. The eating period was reduced to 1.5 min. on Day 10. These liberal criteria were used to prevent the loss of Ss. The Ss were housed 4 or 5 Ss to a cage and the order in which the 10 cages was tested varied randomly from day to day throughout the experiment. Fifteen min. after Ss in the fifth cage were run, Ss in the first five cages were fed for 1 hr. in the home cages. The same procedure was followed for the second five cages.

On the next 30 days Ss had a single acquisition trial per day. The Ss in Group 0 were never delayed, Ss in Groups 20, 50, 80 and 100 were confined for 20 sec. in the goal box on 20-, 50-, 80-, and 100-per cent of the trials with the same patterns of delay as in Exp. 1. A 2-min. running criterion and a 1-min. eating period were in effect in acquisition.

During the next 10 days Ss were given one extinction trial daily. The food compartment was thoroughly cleaned and its door remained in the down position. On every trial S was confined in the goal box for 20 sec., and a 2-min. running criterion was used.

Results

Again the running times were transformed into reciprocals, and the results are shown in Figure 2. Since Ss had only three pretraining trials the groups' means were multiplied by 5/3 to make the pretrain-

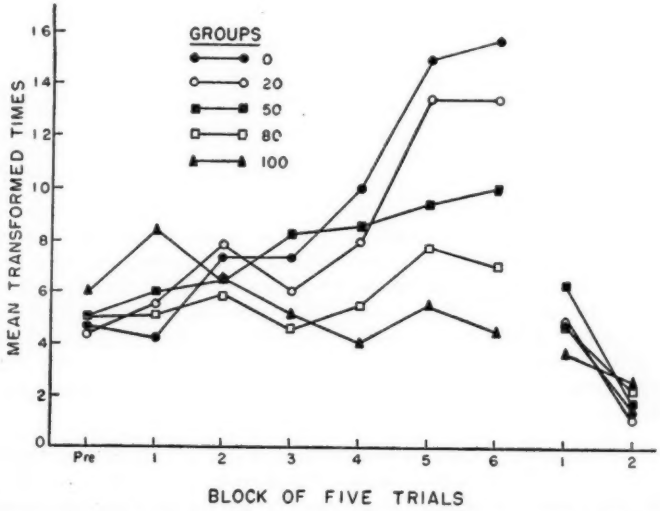

Fig. 2. Mean reciprocal running times in pretraining (Pre.) acquisition (blocks 1-6), and extinction (blocks 1-2).

ing means comparable to the rest of the figure. A simple analysis of variance of the pretraining scores revealed that the groups were initially comparable: $F<1$; $df=4,40$; $P>.05$.

In the total acquisition period the over-all differences between the groups did not deviate from chance variation ($F=2.20$; $df=4,40$; $P>.05$) as shown by a simple analysis of variance. An analysis for trials 26-30 disclosed that the means of the groups were significantly different: $F=5.05$; $df=4,40$; $P<.005$. As in Exp. 1, the variances were not homogeneous ($.02>P>.01$), but again a non-parametric analysis resulted in the rejection of the null hypothesis ($H=14.54$; $df=4$; $P<.006$). Following the same rationale discussed in Exp. 1, we rejected the null hypothesis and proceeded with treatment comparisons using Duncan's method. Group 0 ran faster than both Groups 80 and 100, and Group 20 was superior in speed to Group 100. These differences are all significant at the .01 level of comparison. Again, as in Exp. 1, an inverse relationship is apparent between the percentage of delay and speed of running at the termination of acquisition.

A simple analysis of variance revealed that the percentage of delay in acquisition had no significant influence upon the over-all mean speed scores in extinction: $F<1$; $df=4,40$; $P>.05$. When the extinction scores

were adjusted for the inequalities existing at the end of acquisition, by means of an analysis of covariance, the extinction differences still failed to achieve statistical significance: $F=2.51$; $df=4,39$; $P>.05$). We may conclude therefore, that no reliable extinction differences were obtained in Exp. 2.

DISCUSSION

In both of the present experiments speed of running at the termination of training was inversely related to the percentage of partially delayed reinforcement, and no reliable differences among the delay groups were found during extinction. Both of these results are contrary to the two provisional generalizations stated in the Introduction—generalizations which were based mainly upon studies where relatively short intertrial intervals were imposed. On the basis of all studies including the present ones, three conditions seem to be important for partial delay of reinforcement to retard performance in acquisition: 1. long delay intervals; 2. high percentages of delay; and 3. widely distributed trials. Comparison of Exp. 1 and 2 suggests the possibility that the use of a separate goal box facilitates the occurrence of differences among the delay groups in acquisition. Because the procedures for the two experiments varied in a number of other respects, however, this conclusion must be regarded as a tentative one.

The variable of partial delay of reward has not been incorporated into the major theories of learning. Spence (1956, p. 164) has discussed *continuous* delay of reinforcement and proposed that the magnitude of delay, T_G, and number of delays, $N_T>0$, affect an intervening inhibitory variable, I_T, which in turn, combines in a subtractive fashion to convert excitatory potential, E, into momentary effective excitatory potential $\overline{E}$. He has also indicated the possibility that magnitude of delay might affect incentive motivation, K. In his discussion (1956, p. 83) of the relationships between habit strength, H, and drive, D, Spence points out that a multiplicative relationship between the two intervening variables would result, all other things being constant, in diverging acquisition curves; while an additive relationship would lead to curves which are parallel throughout acquisition. If we assume with Spence that H is independent of delay of reward, then the diverging curves observed in both of the present experiments suggest that delay affects a factor like K which is related in a multiplication fashion to H.

The failure of delayed reinforcement to produce enhanced resistance to extinction in the present experiments with a long intertrial interval in contrast to previous extinction findings with relatively short intertrial intervals requires exploration. In unpublished research (Wike, Kintsch & Gutekunst 1958) performed in our laboratory with relatively short intertrial intervals we have found that rats which received training patterns in which immediate reinforcement always followed delayed reinforcement ran faster during extinction than Ss

with either immediate reward followed by delayed reward or Ss which had continuous immediate reward. This study implies that the superior resistance to extinction after partially delayed reinforcement which has been observed in earlier studies is due to the presence in training of immediate reward *after* delayed reward rather than to delay of reinforcement *per se*. If such patterning effects are responsible for greater resistance to extinction in partial delay of reinforcement, the conditioning of the patterns would necessitate relatively short intertrial intervals. In the present two studies delay is followed by immediate reward, but the 24-hr. intertrial interval is not conducive to pattern formation.

Finally, it should be stressed that in all of the investigations of partial delay and runway performance which have been carried out to date the extinction behavior is confounded by generalization effects since the delayed groups have been switched to a uniform condition of no delay in extinction. Additional studies are, therefore, needed in which subgroups of each delay group in acquisition are exposed to all delay conditions in extinction.

SUMMARY

Two runway experiments were performed to investigate the effects of partially delayed reinforcement under widely distributed (24-hr. intertrial interval) training. In Exp. 1 Ss ($N=38$) were trained with 20-sec. delays on 0-, 20-, 50-, 80-, and 100-per cent of the trials and 10-30 sec. delays on 50- and 100-per cent of the trials. The delays took place in a delay box just in front of the goal box. In Exp. 2 ($N=45$) the first five conditions of delay were studied and delay was imposed in the goal box, itself.

Both experiments disclosed an inverse relationship between percentage of delay and runway speed at the end of acquisition. In both experiments no reliable differences were found among the delay groups during extinction. These results are contrary to the previous findings on partial delay where short intertrial intervals were involved. The acquisition results were discussed in terms of Spence's version of behavior theory, and the incompatibility of the present extinction results with earlier results was related to patterning effects in partial delay.

REFERENCES

CRUM, JANET; BROWN, W. L., & BITTERMAN, M. E. The effect of partial and delayed reinforcement on resistance to extinction. *Amer. J. Psychol.*, 1951, 64, 228-237.

DUNCAN, D. B. Multiple range and multiple F tests. *Biometrics*, 1955, 11, 1-42.

FEHRER, ELIZABETH. Effects of amount of reinforcement and pre- and post reinforcement delays on learning and extinction. *J. exp. Psychol.*, 1956, 52, 167-176.

KINTSCH, W., & WIKE, E. L. Habit reversal as a function of length of partial delay of reinforcement. *Psychol. Rep.*, 1957, 3, 11-14.

LINDQUIST, E. F. *Design and analysis of experiments in psychology and education.* New York: Houghton Mifflin, 1953.

LOGAN, F. A., BEIER, EILEEN M., & ELLIS, R. A. Effect of varied reinforcement on speed of locomotion. *J. exp. Psychol.*, 1955, 49, 260-266.

LOGAN, F. A., BEIER, EILEEN M., & KINCAID W. D. Extinction following partial and varied reinforcement. *J. exp. Psychol.*, 1956, 52, 65-70.

PETERSON, L. R. Variable delayed reinforcement. *J. comp. physiol. Psychol.*, 1956, 49, 232-234.

SCOTT, E. D., & WIKE, E. L. The effect of partially delayed reinforcement and trial-distribution on the extinction of an instrumental response. *Amer. J. Psychol.*, 1956, 69, 264-268.

SPENCE, K. W. *Behavior theory and conditioning.* New Haven: Yale Univ. Press, 1956.

WATSON, J. B. The effect of delayed feeding upon learning. *Psychobiol.*, 1917, 1, 51-60.

WIKE, E. L., & McNAMARA, H. J. The effects of percentage of partially delayed reinforcement on the acquisition of an instrumental response. *J. comp. physiol. Psychol.*, 1957, 50, 348-351.

WIKE, E. L., KINTSCH W., & GUTEKUNST, R. Patterning effects in partially delayed reinforcement. Unpublished research, 1958.

The Psychological Record, 1959, 9, 29-32.

THE EFFECT OF INTENSITY OF VISUAL STIMULATION UPON AUDITORY ACUITY

W. L. GULICK AND F. L. SMITH

University of Delaware

Data on sensory interaction are contradictory: whereas a number of investigators report that the sensitivity of one modality is heightened during simultaneous stimulation in a second modality (Child & Wendt, 1938; Hartmann, 1933; Hartmann, 1934; Kravkov, 1934; Urbantshitsh, 1888), other investigators report that simultaneous stimulation of a second modality either has no effect (Serrat & Karwoski, 1936) or actually decreases sensitivity in the first (Heymans, 1904; Jacobson, 1911). The fact than phenomena of sensory interaction are complex is amply demonstrated by the work of Child and Wendt (1938) on the role of temporal separations of the onset of stimulation in two modalities, and the work of Gregg and Brogden (1952) on the role of attention. The literature makes it clear that shifts in thresholds due to sensory interaction are difficult to demonstrate.

One factor which may have contributed to the contradictory nature of data on interaction is the intensity relationship of stimuli acting upon two sense modalities. Intensity as a parameter in sensory interaction has been suggested as important (Hartmann, 1933; Jacobson, 1911; Thorne, 1934), but no evidence bearing directly upon the issue of intensity relationships is available. In stating the role of intensity, Thorne (1934) proposed that the sensitivity in one modality could be increased by simultaneous stimulation in other modalities (auxiliary) as long as the auxiliary stimulation was sufficiently weak to be perceived as the ground in the figure-ground relationship. However, differential interaction as a function of the relationship of the intensities of stimuli acting on different modalities remains to be demonstrated, as does the usefulness of the figure-ground construct in this connection.

The investigation reported here sought to determine the effect of three levels of intensity of homogeneous visual stimulation on auditory acuity, as measured by *O*'s ability to discriminate differences of pitch and timbre A homogeneous visual field was used to minimize any possible distracting effects as a result of *O*s attending to meaningful visual stimuli.

METHOD

Observers

Twelve *O*s were used, and all were naive concerning the purpose of the investigation. Each *O* met a criterion of not more than a 5 db hearing loss in each ear at 256, 512, 1024, and 2048 cps.

Apparatus

The *O*s listened to pitch and timbre discrimination tasks in an air conditioned light- and soundproof room (minimum ambient noise level, 30 db SPL). Room temperature was constant at 70°F. Three conditions of illumination were used: darkness, O.12, and 1.20 candles per square foot (conditions I, II, and III, respectively). Illumination was produced by incandescent bulbs located behind the chair in which *O* sat. A rubber-lined clamp attached to the back of the chair held *O*'s head firmly, prohibiting extensive movement. Two translucent celluloid hemispheres (3.9 cm. in diameter), shaped to fit the contour of the face, were placed over *O*'s eyes and held by a transparent mask.

Pitch and timbre discrimination tasks were recorded on tape and the signal was transmitted to *O* over earphones (Telephonics Corp., N.Y., Type TH-37, 300-z) at an intensity of approximately 70 db SL. On the pitch tape (Scale P) one of the two tones in each discrimination task was always a standard tone of 500 cps. while the other one differed from 500 cps. in one-half cycle intervals from 500.5 to 509.0 cps. On the timbre tape (Scale T) the standard complex tone was composed of a fundamental of 500 cps. and overtones of 1,000, 1,500, and 2,000 cps. whereas the other complex timbre tone differed from this standard by having the intensity of its 1000 cycle partial from 1 to 18 db less intense. The standard tone appeared an equal number of times as the first and second tone in the 36 discrimination tasks on both Scales. The duration of each tone was two seconds, and the two discriminanda were separated by a two second interval of silence. A 10-sec. interval of silence separated successive discrimination pairs.

For Scale P and Scale T the 36 discriminations in each scale were actually two random orders of 18 unique stimuli pairs, the odd-numbered ones (1-35) being one order and the even-numbered ones (2-36) being a second order of the same pairs of stimuli. Each *O*, therefore, heard each of 18 pitch and each of 18 timbre pairs twice in each condition of illumination.

Procedure

All six possible orders of the three conditions were used, with two *O*s following each order. Of these two, one *O* heard Scale P and then Scale T in each condition, and the other heard Scale T and then Scale P in each condition.

The *O*s were run one at a time. After the translucent celluloid hemispheres, the transparent mask, and the earphones were placed on *O*, the adjustable clamp was securely fastened about *O*'s head. The *O* was requested not to touch any of the affixed apparatus and not to close either or both eyes, except for a normal blink, during the entire experiment.

Instructions were read by *E* informing *O* to judge the successive

tones within a pair as the *same* or *different* and then to make a verbal reply. After instruction each *O* was given 10 practice trials on each of the two types of discrimination tasks. All practice trials were performed under bright general illumination (20 candles per square foot). When the 10 practice trials were completed for that Scale to be performed first, illumination for the first condition for that Scale was set. The *E* started the tape recorder located in an adjacent control room and then moved to the experimental room in order to record *O*'s responses. A similar sequence was employed after the completion of the 10 practice trials for the second Scale to be performed in the first condition. Except for the exclusion of the practice trials, the procedure for the second and third illumination conditions remained unaltered.

During a five minute rest period between experimental conditions *E* removed the affixed apparatus from *O* who was then allowed to walk about inside the experimental room.

The *O* was reminded after every nine responses to keep both eyes open.

RESULTS AND DISCUSSION

The results of this experiment indicate that the three levels of intensity of homogeneous visual stimulation neither facilitated nor inhibited *O*'s ability to discriminate differences of pitch and timbre.

The scores used in the analysis of variance were the number of correct discriminations reported by each *O* on each of the two orders of 18 discrimination tasks for Scale P and Scale T, in each experimental condition. Since the two tones presented in each discrimination task were never the same, the total possible score was 18. However, preliminary investigation aided in devising discrimination scales sufficiently difficult to produce scores of about 11.

The mean scores for experimental conditions I, II, and III were 11.21, 11.33, and 11.37 respectively, and these scores were found to differ insignificantly from each other.

In the course of each *O*'s progress through the three illumination conditions, it was assumed that the effect of learning, fatigue, and fluctuations of attention contributed equally to each illumination condition as a result of the experimental design employed. Although these effects were not isolated statistically, some information about their total effect may be got by examining the mean performance score for all *O*'s in their first, second and third conditions. These three means were 11.71, 11.48, and 10.73 for the first, second, and third conditions, respectively. Mean scores for the first and third conditions were found to be significantly different from each other at the .05 level of confidence. If the assumption is tenable that 10 practice trials were sufficient to level off the learning curve, then fatigue or progressive loss of interest, or both, might explain this slight decline in performance from the first to the third condition.

Although the intensity relationship of stimuli acting upon two sense modalities has been suggested as important to demonstrations of sensory interaction, data from the present experiment indicate that within the limits studied, discrimination of pitch and timbre are not differentially affected by the intensity of diffuse stimulation of the retinae. In fact, no evidence of interaction was obtained under any of the experimental conditions employed. It is possible that extremely intense light would affect auditory acuity, but this effect might better be viewed as the result of distraction rather than interaction. It may be that the conditions of sensory interaction are more intimately connected to attention and distraction than they are to simple temporal and intensity relationships obtaining during stimulation.

SUMMARY

Twelve *O*s with normal hearing listened to tape recordings of 36 pitch and 36 timbre discrimination tasks in each of three illumination conditions. Two translucent celluloid hemispheres, shaped to fit the contour of the face, were placed over *O*'s eyes and held with a transparent mask. Orders of discrimination tasks and experimental conditions were randomized to balance learning and fatigue effects.

On the basis of this investigation no evidence was obtained to indicate that visual stimulation from a homogeneous field affects auditory acuity.

REFERENCES

CHILD, I. L. & WENDT, G. R. The temporal course of the influence of visual stimulation upon the auditory threshold, *J. exp. Psychol.*, 1938, 23, 109-127.

GREGG, L. W. & BROGDEN, W. J. The effect of simultaneous visual stimulation on absolute auditory sensitivity, *J. exp. Psychol.*, 1952, 43, 179-186.

HARTMANN, G. W. Changes in visual acuity through simultaneous stimulation of other sense organs, *J. exp. Psychol.*, 1933, 16, 393-407.

HARTMANN, G. W. The facilitating effect of strong general illumination upon the discrimination of pitch and intensity differences, *J. exp. Psychol.*, 1934, 17, 813-822.

HEYMANS, G. Untersuchungen ueber psychische Hemmung: V. Die Verdraengung von Schallempfindungen durch elektrische Hautempfindungen, *Zsch. f. Psychol.*, 1904, 34, 15-28.

JACOBSON, E. Experiments on the inhibition of sensations, *Psychol. Rev.*, 1911, 18, 24-53.

KRAVKOV, S. V. Changes of visual acuity in one eye under the influence of the illumination of the other or acoustic stimuli, *J. exp. Psychol.*, 1934, 17, 805-812.

SERRAT, W. D. & KARWOSKI, T. An investigation of the effects of auditory stimulation on visual sensitivity, *J. exp. Psychol.*, 1936, 19, 604-611.

THORNE, F. C. The psychophysical measurement of the temporal course of visual sensitivity, *Arch. Psychol., N. Y.*, 1934, No. 170.

URBANTSCHITSCH, V. Ueber den Einfluss einer Sinneserregung auf die uebrigen Sinnesempfindungen, *Pfluegers Archiv.*, 1888, 42, 154-182.

The Psychological Record, 1959, 9, 33-35.

DISTAL CUES AND LATENT EXTINCTION

M. RAY DENNY AND STANLEY C. RATNER
Michigan State University

The concept of latent extinction refers to the observation that the strength of a learned, instrumental response can be weakened prior to non-reward trials. This weakening is accomplished by simply placing the animal in the reward area for a period of time when no reward is available. Seward and Levy's (1949) observation of latent extinction was considered to be embarrassing to S-R theory, since it implied that ". . . all that seems necessary for extinction is for the organism to *perceive* the absence of reinforcement" (Deese, 1952, p. 62).

Moltz (1957) has subsequently made an elaborate S-R analysis of the latent extinction situation in terms of fractional anticipatory goal responses. However, there is still an apparent contradiction in the latent extinction literature of a fundamental sort.

When Bugelski, Coyer and Rogers (1952) replicated the original Seward and Levy study (1949) they found no evidence of a latent extinction effect. Examination of the procedures of both studies suggested that Seward and Levy (1949) placed one end of the runway near a wall while the other workers (Bugelski et al, 1952) placed their alley in the middle of a large room. These suppositions were confirmed by personal communications.

Given differential extra-maze stimuli at each end of the runway, per Seward and Levy, it follows that avoidance responses elicited by an *empty* goal platform during latent extinction trials would be discriminatively conditioned to the extra-maze stimuli at the goal-end and thereby mediate latent extinction effects (avoidance *a la* increased latency). On the other hand, if the distal stimuli were similar, as in the replication (Bugelski et al, 1952), they would be irrelevant for both approach *and* avoidance and no latent extinction effect would be expected. The present study checks on and supports this analysis.

METHOD

Twenty female albino rats, 90-129 days old, were trained to run a 4-ft. white runway, including starting section, into a 14 x 10-in. goal box with black interior and white exterior. An arched ½-in. hardware cloth ceiling covered the alley at a height of 4 in. and afforded S a view of the extra-maze stimuli.[1]. The wooden sides of the alley were only 2 in. high and the alley was 3¾ in. wide. The guillotine door at

[1] The runway was so constructed because 10 additional curtain vs. no curtain Ss, not being reported on, were restrained in a central alley section during latent extinction trials. Essentially, they extinguished like the experimental groups herein reported.

the goal box was white on the alley side and black on the other, while the start box door was all white. The runway was located approximately in the middle of a large room. Ten Ss were trained with a 10 x 15-ft. heavily pleated burlap curtain immediately behind the goal box and ten were trained without it. After seven days of handling and a 23-hr. food deprivation schedule all Ss received four learning trials per day for five days. A .10-gm pellet in a small permanent cup in the goal box served as a reward on each trial. Latency to a line 4 in. beyond the starting box and running time from this line until S had two feet in the goal box were recorded.

For latent extinction each group was sub-divided into two equal groups. The latent extinction sub-groups received five 2-min. extinction sessions in the empty goal box with all other conditions the same as during training. The control sub-groups received five 2-min. sessions in an empty 1 x 1 x 1-ft. metal box located 20 ft. from the goal box and off to the side of the start-box. Extinction followed immediately for all Ss, with the curtain present only for the curtain group. An inter-trial interval of 2 min. was used throughout all phases. During extinction Ss were run until there were two consecutive latencies of 3 min. or for 25 extinction trials. One S in the latent-curtain group reached criterion before 25 trials.

RESULTS AND DISCUSSION

Medians of the mdn latency for the last five learning trials for the curtain and no curtain groups were almost identical (5.8 and 6.0 sec.) as were the medians of the mdn running time (3.5 and 4.0 sec.). Mann-Whitney *U* tests were conducted on the first and last blocks of five

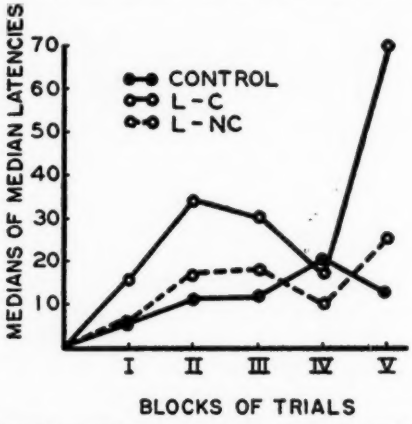

Fig. 1. Medians of median latencies (sec.) for each group during extinction.

extinction trials for both latency and running time. The control groups were combined as no difference between them approached significance.

A comparison of the groups in Fig. 1 shows the median of the mdn latency for each block of five extinction trials.

There is good evidence of latent extinction for the latent extinction-curtain group (L-C) and possibly slight evidence for the latent extinction-no curtain group (L-NC). On the crucial latency measure L-C differs significantly not only from the control group on the last block of extinction trials ($U=3$, $p=.01$, $n_1=5$, $n_2=10$) but also from L-NC ($U=2$, $p=.02$, $n_1=n_2=5$).

Statistical analyses of running time results were made on the first and last blocks of extinction trials using medians of mdn running times as measures. Group L-C ran significantly slower than the control group on both the first block of trials ($U=5$, $p=.01$, $n_1=5$, $n_2=10$) and the last block of trials ($U=5$, $p=.01$). Group L-NC ran significantly slower than the control group only on the first block of trials ($U=5$, $p=.01$, $n_1=5$, $n_2=10$). Comparisons between groups L-C and L-NC yielded significant values of U. For the present hypotheses running time is not as sensitive an index of the curtain effect since it is contaminated by the fact that goal box cues may directly affect it.

With the added fact that the results of recent studies support latent extinction (Moltz, 1957) it is concluded that the introductory analysis is essentially correct and that the aforementioned contradiction is resolved.

SUMMARY

The hypothesis was tested that the failure of Bugelski et al (1952) to obtain latent extinction effects in a "replication" of Seward and Levy's (1949) latent extinction study was due to the absence of differential extra-maze stimuli at the ends of the runway in Bugelski's study. In the present study rats were run with and without differential cues and the results supported the hypothesis thus resolving the apparent contradiction.

REFERENCES

BUGELSKI, B. R., COYER, R. A., & ROGERS, W. A. A criticism of pre-acquisition and pre-extinction of expectancies. *J. exp. Psychol.*, 1952, 44, 27-30.

DEESE, J. *The psychology of learning.* New York: McGraw-Hill, 1952.

MOLTZ, H. Latent extinction and the fractional anticipatory response mechanism. *Psychol. Rev.*, 1957, 64, 229-242.

SEWARD, J. P., & LEVY, N. Sign learning as a factor in extinction. *J. exp. Psychol.*, 1949, 39, 660-668.

BOOKS RECEIVED

BOHM, E. *Rorschach Test Diagnosis.* New York: Grune & Stratton, 1958. Pp. 33

HARROWER, M. *Personality Change and Development.* New York: Grune & Stra ton, 1958. Pp. 383.

BROWER, D. & ABT, L. *Progress in Clinical Psychology.* New York: Grune Stratton, 1958. Pp. 249.

EDWARDS, A. *Statistical Analysis.* New York: Rinehart, 1958 Pp. 234..

KANTOR, J. R. *Interbehavioral Psychology.* Bloomington, Indiana: Principia Pre 1958. Pp. 238.

GREENWALD, H. *The Call Girl.* New York: Ballantine, 1958. Pp. 237.

ARNOLD, P. *Rate Yourself.* New York: Permabooks, 1958. Pp. 165.

HOLLENDER, M. H. *The Psychology of Medical Practice.* Philadelphia: Saund ers, 1958. Pp. 276.

HEBB, D. O. *A Textbook of Psychology.* Philadelphia: Saunders, 1958. Pp. 27

KARON, B. *The Negro Personality.* New York: Springer, 1958. Pp. 184.

GRAHAM, T. *Dynamic Psychopathology.* Boston: Christopher, 1957. Pp. 251.

McGUIGAN, F. J. & CALVIN, A. D. *Current Studies in Psychology.* New Yor Appleton-Century-Crofts, 1958. Pp. 226.

WOLSTENHOLME, G. E. W. & O'CONNOR, C. M. (Eds.) *Ciba Fundation Sy posium on the Neurological Basis of Behavior.* Boston: Little, Brown, 195 Pp. 400.

SENDERS, V. *Measurement and Stataistics.* New York: Oxford, 1958 Pp. 594.

HARRELL, T. W. *Industrial Psychology.* New York: Rinehart, 1958. Pp. 398.

SCHUTZ, W. C. *Firo—A Three-Dimensional Theory of Interpersonal Behavio* New York: Rinehart, 1958. Pp. 267.

WOLSTENHOLME, G. E. W. & MILLAR, E. C. P. (Eds.) *Ciba Foundation Sy posium on Extrasensory Perception.* Boston: Little, Brown, 1956. Pp. 2

COLE, L. E. & BRUCE, W. F. *Educational Psychology.* New York: World, 195 Pp. 701.

DULANY, D. E. et al. *Contributiions to Modern Psychology.* New York: Oxfor 1958. Pp. 398.

LINDZEY, G. *Assessment of Human Motives.* New York: Rinehart, 1958. Pp. 27

REIK, T. *Of Love and Lust.* New York: Grove Press, 1959. Pp. 623.